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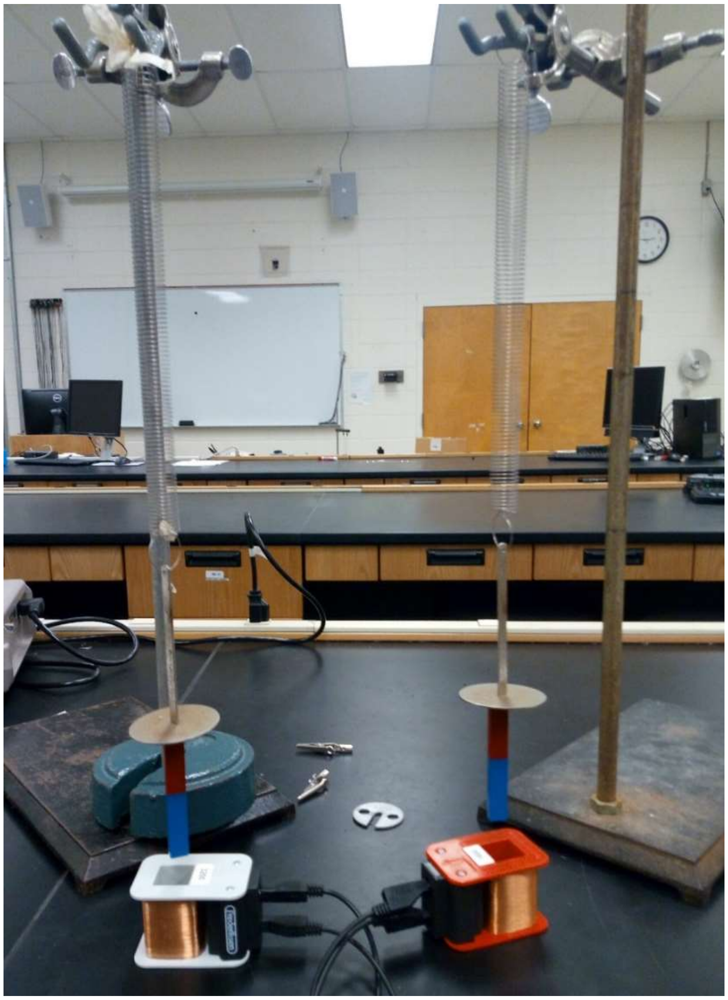
Lab 9 Induction Spring Lab



Supplies:

2 magnets, various coils, Spring setup, less than 10 g mass. Voltage sensor, Computer with data studio

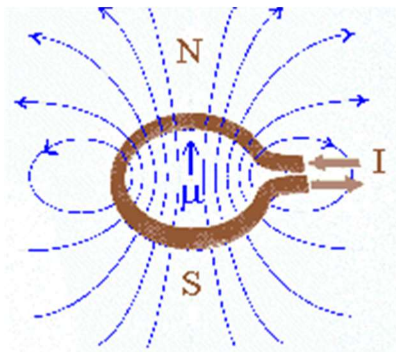
Theory:

Faraday's law states that a changing magnetic flux induces an electromotive force.

$$\mathcal{E} = -N\frac{d\Phi_m}{dt}$$

Where, $\Phi_m = B \cdot A = BA\cos(\theta)$

Therefore, if a magnet oscillates in and out of a coil, it should generate a potential difference across the coil. This induced voltage generates a current which can be transmitted to other electric devices. This current oscillates similarly to the magnetic field. Remember Ohm's Law, V=IR. If the current is transmitted to another coil than a magnetic field is generated in the secondary coil. The magnetic field of a coil acts similarly to a magnet. If the current is flowing so the magnetic field points up through the coil, than the upside of the coil is magnetic North and the downside of the coil is magnetic South.



Which means the north side of a magnet nearby will feel: a repulsion due to the generated north side of a coil, or an attraction to the south side of a coil. Note the current is oscillating, therefore the upside of the coil is alternating between North and South.

Procedure:

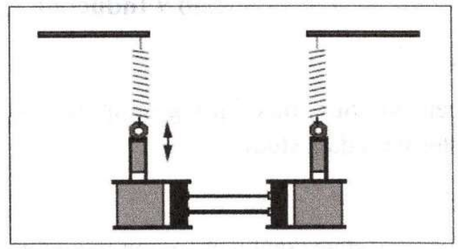


Figure 1

1. Setup two coils, the magnets, springs, and ring stands as shown in Figure 1 and picture above. Make sure you are not over the base of the stand as this becomes magnetic and can cause problems within the experiment.

2. Move the magnet in one coil upward and then release so that it has a simple harmonic motion. Make sure it moves in and out of the coil smoothly. Adjust to find a good position. What happens with the other magnet? Why do you think this is happening?

   The coil on the right was set in motion. Over the course of 5-10 seconds, the coil on the left slowly began to oscillate. The oscillations of the 2 coils were asynchronous initially but the first coil began to match the slower oscillation of the coil on the left. Once the midrange oscillation is established, but coils remain in sync.

3. What will happen if you reverse the leads in on the two coils. Try it. What was the effect of changing the polarity of the leads connecting the two coils? Why?

   The equilibrium established between the ossilation patterns of the 2 coils is determined by the polarity of the (electric) leads. The directionality of the leads will transmit the field generated by the ossilations of 1 coil as the initial signal. This will be the field to which the system ultimiately equilibriates.

4. What do you think will happen if you add a mass of less than 10 g to one of the magnets, you may need to change the height of the stand?

   The synchronous effect will be less pronounced. Ossilation of weighted coil will be more forceful (initially)

   System will ultimately be damped.

5. Why did the behavior change as a result of changing the mass of the magnet which was used? (Think about first semester physics)

Increasing weight increases inertia and the unweighted magnet in the system won't overcome added inertia. The downward side of the unweighted ossilation will be unable to counter the upward force of the weighted side of the field. Equilibrium will not be reached and the system will be damped.

6. What will happen if you use a different number of coils on one side? Try it. What was the result?

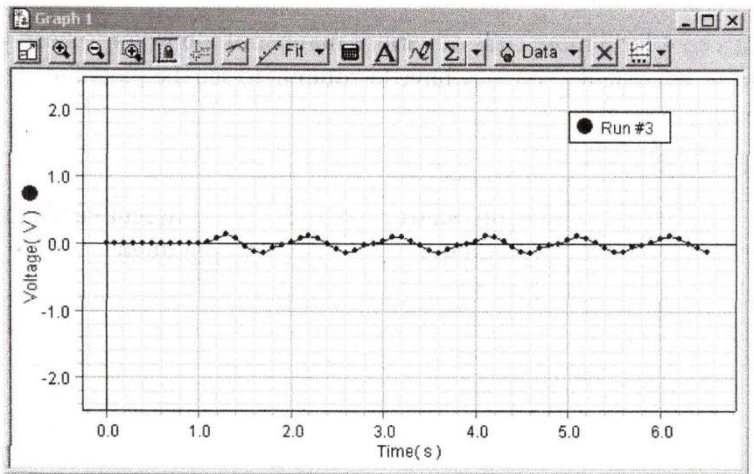
larger number of coils, more vigorous oscillation.
fewer number of coils, slower oscillation and weaker synchronous effect between the oscillating coil and the coil that wasn't set into motion.

7. Why did the magnets behave as they did?

When poles of the magnets are oriented uniformly, equillibrium of ossilation will be reached because the electric field passed between them will ultimately be the same.

The fundamental similarity of the (induced) electric field is the the origion of the magnets' "behavior" in this system.

3. Record the data from part 2 in the table. Average the absolute value of 5 consecutive maximum positive voltage points and their corresponding absolute value of 5 consecutive negative voltage points. The plot may look like the figure below.



Number of Coils: 1600

	5 consecutive Voltage Maximum	5 consecutive Voltage Minimum
	.110	- 0.1075
	.105	- 0.1075
	.105	- 0.115
	.105	- 0.1075
	.105	- 0.1025
Average:	0.106	-0.108

$\frac{|V_{max}| + |V_{min}|}{2} =$ 0.107 V

4. What happens if you change the polarity? Switch the leads and redo part 2. What did you discover? Why do you think that is the case?

5. Repeat step 4 for 3 more coils of various number of loops, try to keep your amplitude consistent. You may have to zoom in to see the plots for some of the coils.

Number of Coils: 800

	5 consecutive Voltage Maximum	5 consecutive Voltage Minimum
	0.06	-0.0575
	0.06	-0.0575
	0.055	-0.0575
	0.055	-0.0575
	0.055	-0.0575
Average:	0.057	-0.0575

$\frac{|V_{max}|+|V_{min}|}{2}=$ 0.057 V

Number of Coils: 400

	5 consecutive Voltage Maximum	5 consecutive Voltage Minimum
	0.027	-0.025
	0.027	-0.025
	0.027	-0.025
	0.027	-0.025
	0.027	-0.025
Average:	0.027	-0.025

$\frac{|V_{max}|+|V_{min}|}{2}=$ 0.026 √

Number of Coils: 200

	5 consecutive Voltage Maximum	5 consecutive Voltage Minimum
	0.0175	-0.019
	0.0175	-0.019
	0.0175	-0.019
	0.0175	-0.019
	0.0175	-0.019
Average:	0.0175	-0.019

$\frac{|V_{max}|+|V_{min}|}{2}=$ 0.018 √

How did the Voltage change when you changed the number of coils?

larger number of turns, larger voltages

Plot the average voltage (y-axis) versus the number of coils. What is your slope?

Slope $= 6 \times 10^{-5}$

What does the slope represent? (Think about Faraday's Law)

Fundamentally, the slope works as an analysis of the amount by which Voltage increases with each unit 2·n ['n' referring to the number of conductor turns (base of 200) added to the System] turns of wire loops added to the System.

Relative to Faraday's Law, our data may be understood as being a broader picture of the linear development of voltage — based on a multi-tiered "system" of amplification (wire loops) component, rather than application of a (more essential) Time element.

Summarize what you learned in 3-5 sentences.

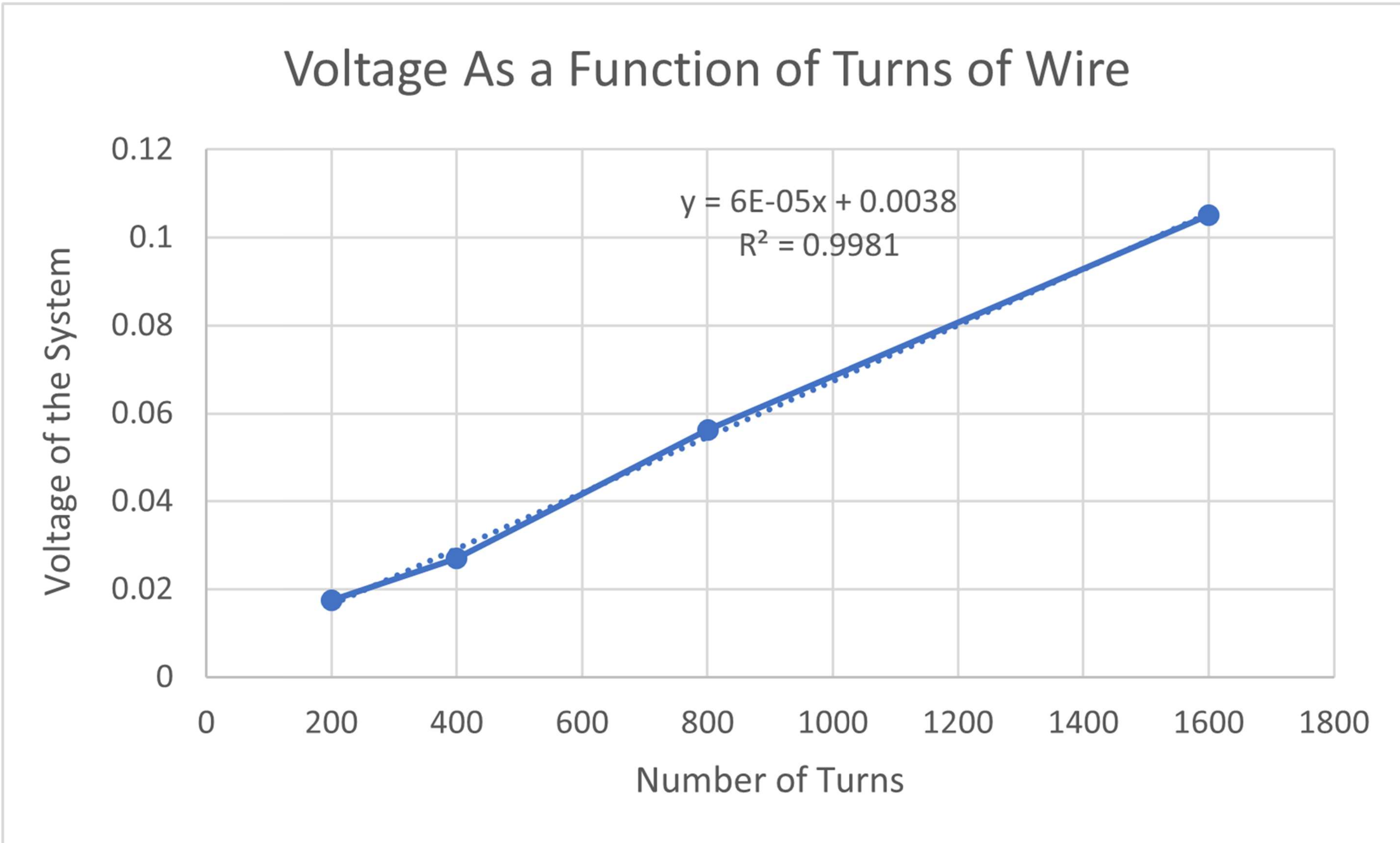
The primary aim of this lab is to study the effect of magnetic Polarities (especially altered by varying the number of wire loops) on systemic generation of voltage. Our group focused on the poles of the magnets themselves (suspended from coils), while also reversing polarity of the circuitry transmitting the inductive effect between our (2) generative coils.

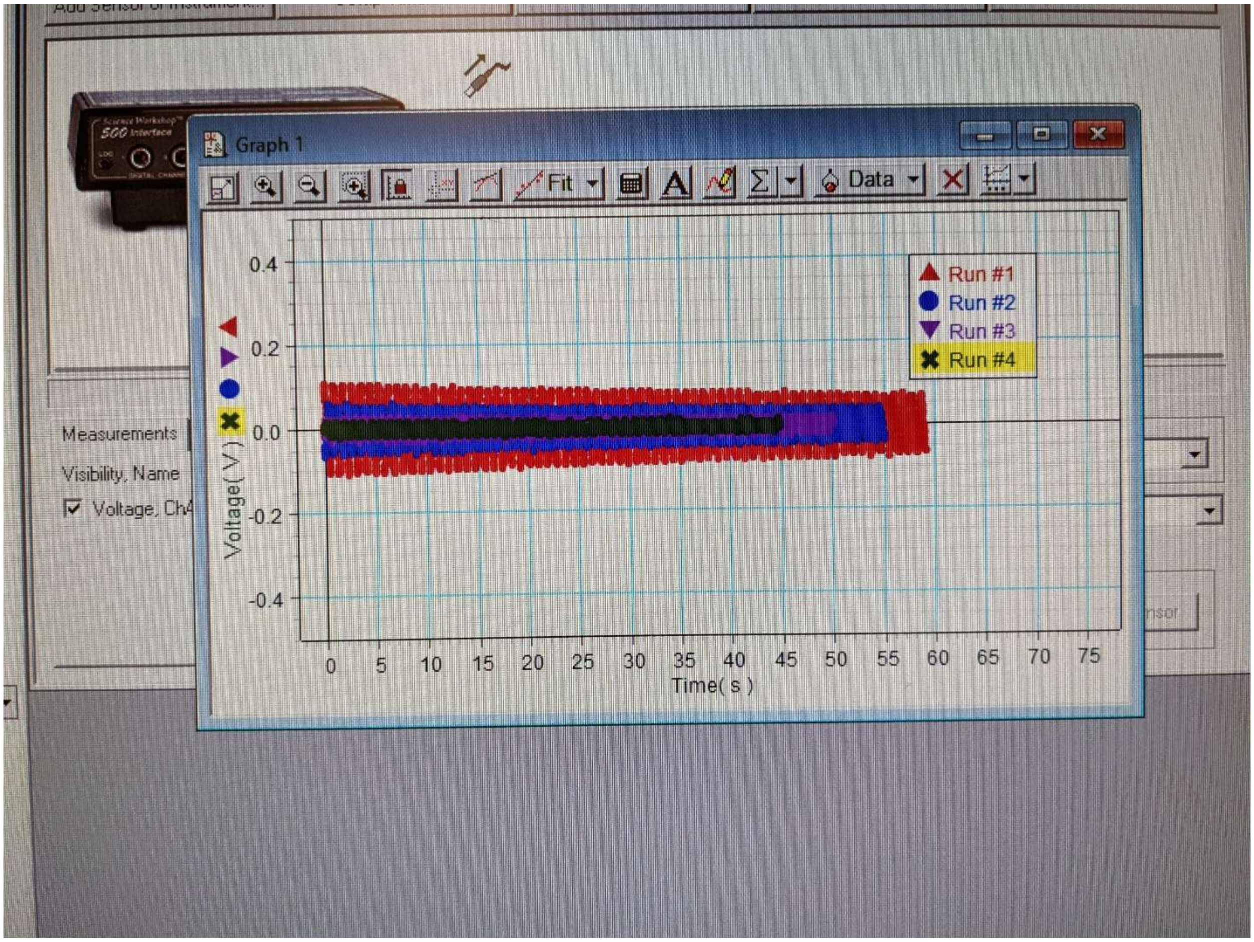
When the magnetic poles are in the same orientation ('+' up, or both '−' up) equilibrium of oscillation is established eventually, and the electric field Passed between them will be the same.

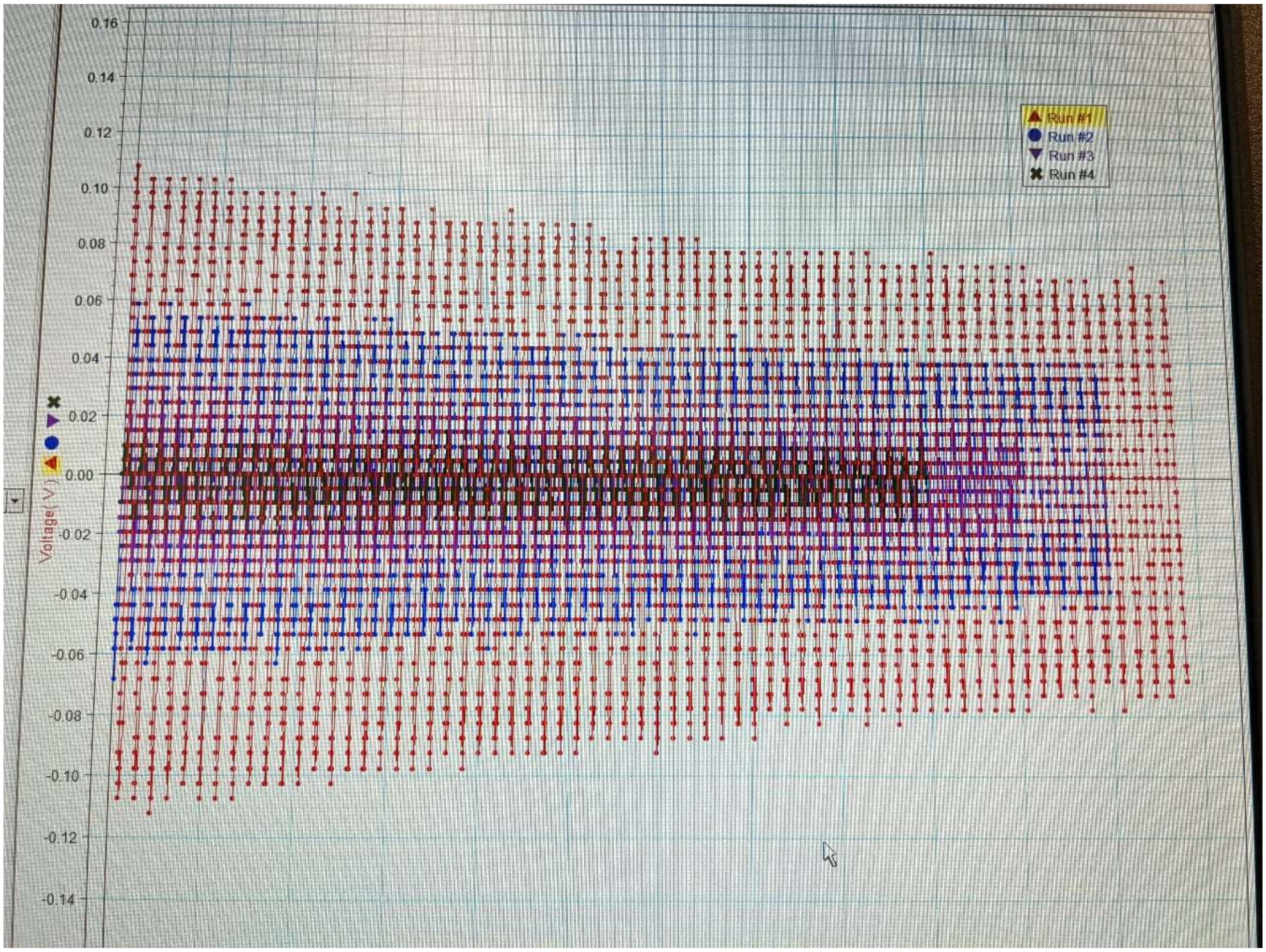
Similarly, as the number of wire loops decreases (with magnets still retaining identical orientation) equilibrium of (mutual) oscillation will still be achieved, but will be weaker (smaller amplitude).

Alternately, when polarities of the magnets are opposite one another, the oscillations achieved (including that adopted by the magnet that recieves the induced field) by the system will not reach equilibrium. Instead, they will be out of phase (asynchronoos).

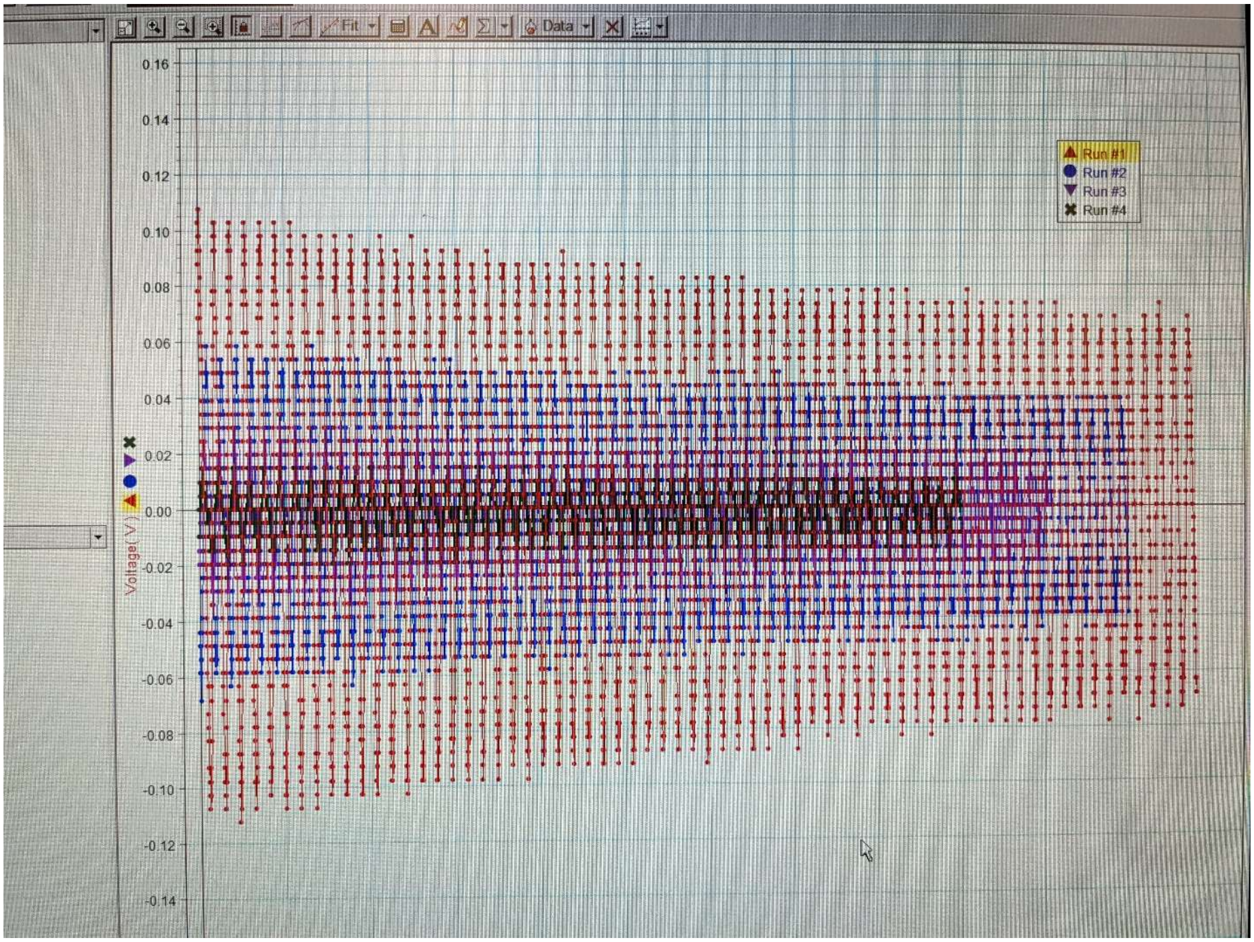
These are fundamental interactions, very effectively depicted by our experimental Process and by the activity overall.

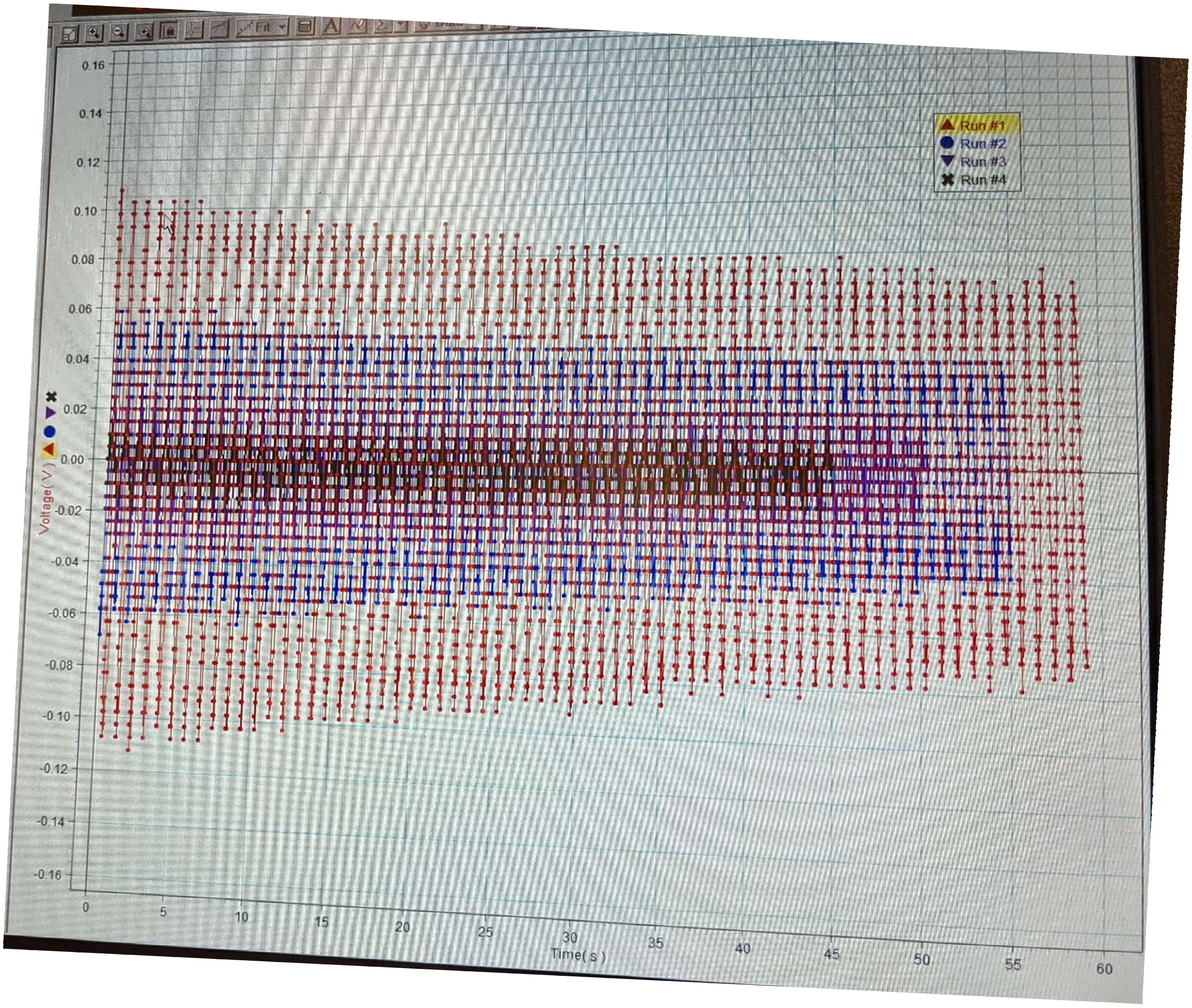

Voltage As a Function of Turns of Wire
y = 6E-05x + 0.0038
R² = 0.9981
Voltage of the System
0.12
0.1
0.08
0.06
0.04
0.02
0
0
200
400
600
800
1000
1200
1400
1600
1800
Number of Turns


Graph 1
Fit
Data
Run #1
Run #2
Run #3
Run #4
Voltage(V)
Time(s)
0.4
0.2
0.0
-0.2
-0.4
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Measurements
Visibility, Name
Voltage, ChA

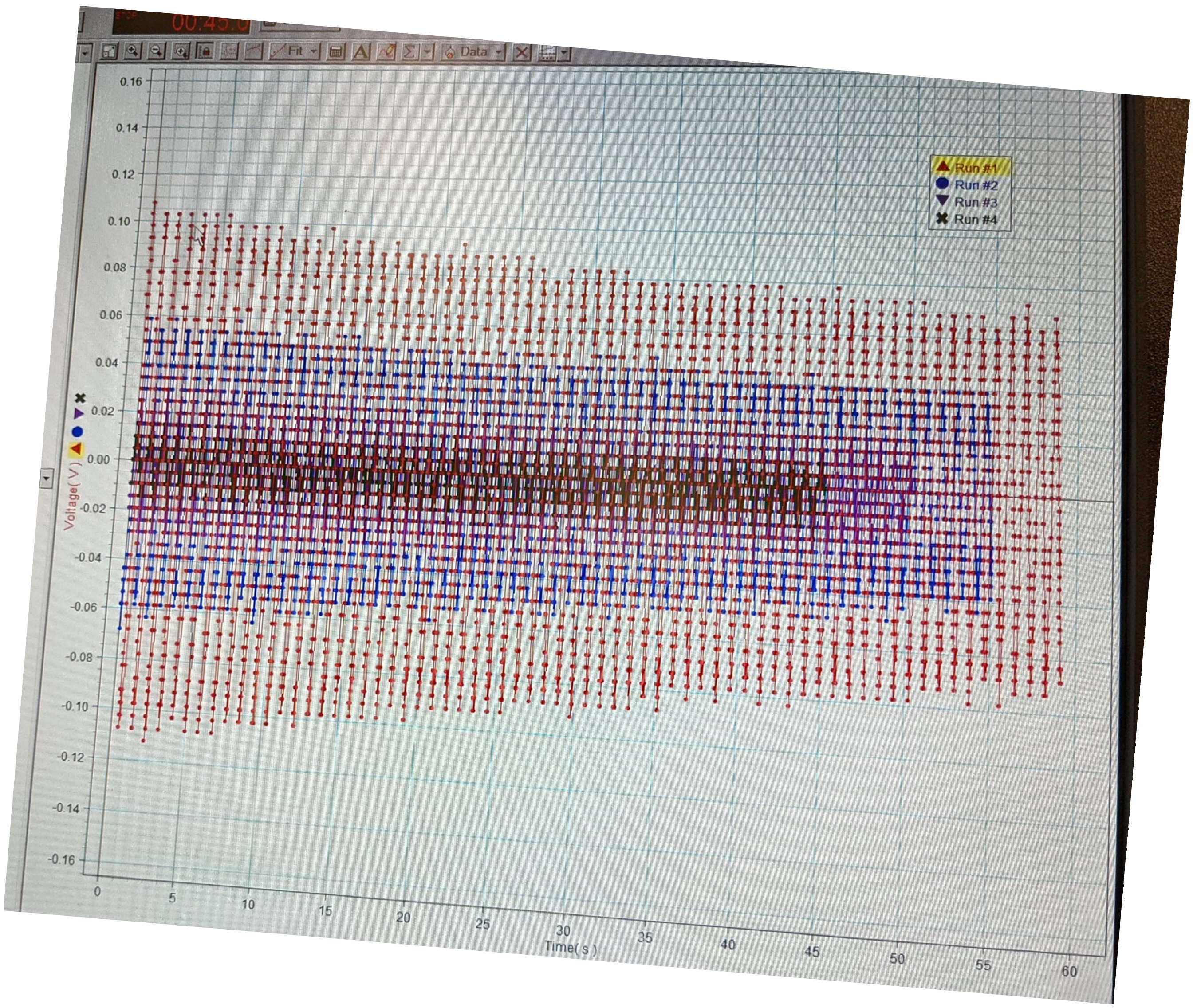


0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
Voltage (V)
Run #1
Run #2
Run #3
Run #4

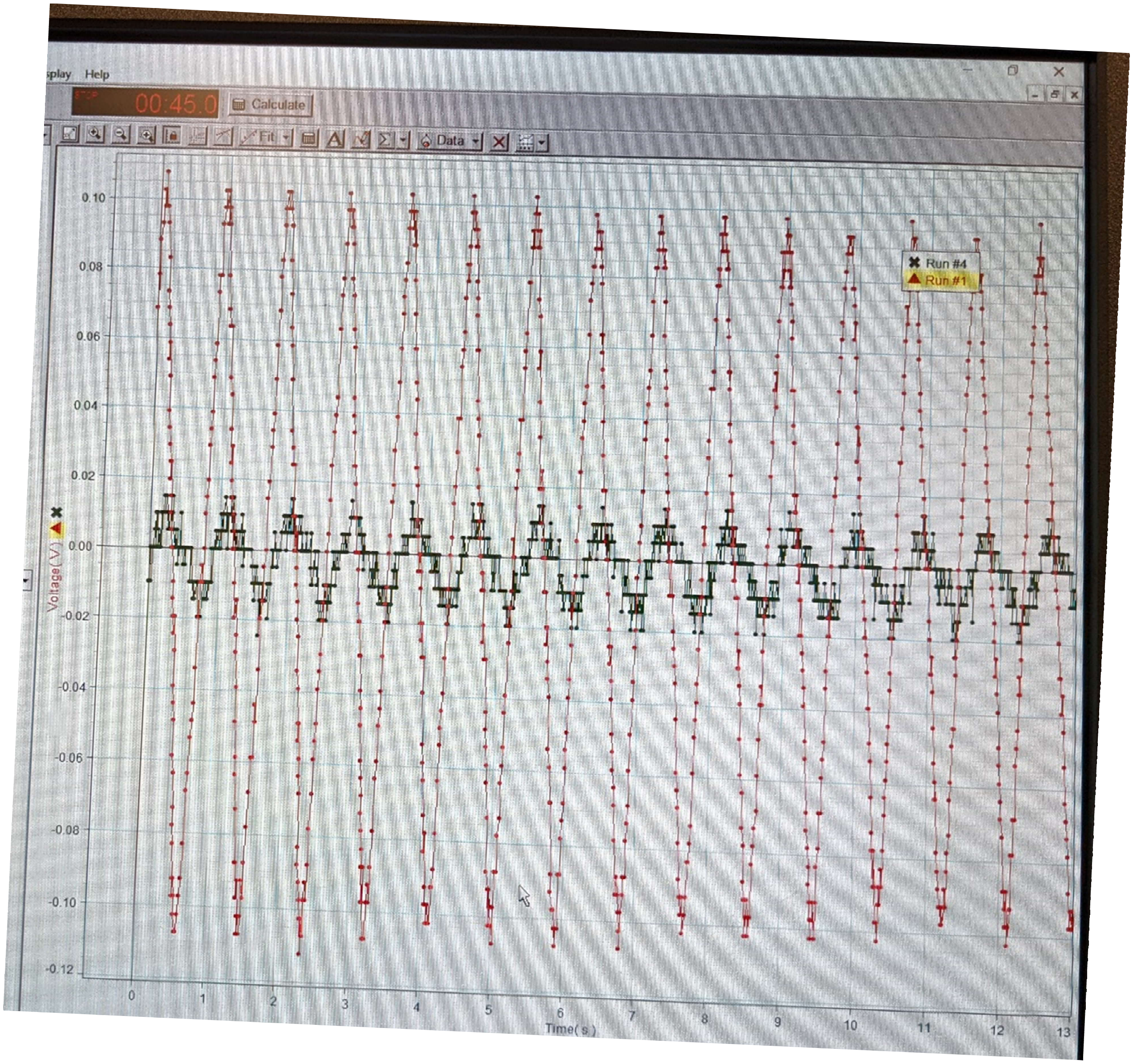

Fit
Data
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
Voltage (V)
Run #1
Run #2
Run #3
Run #4



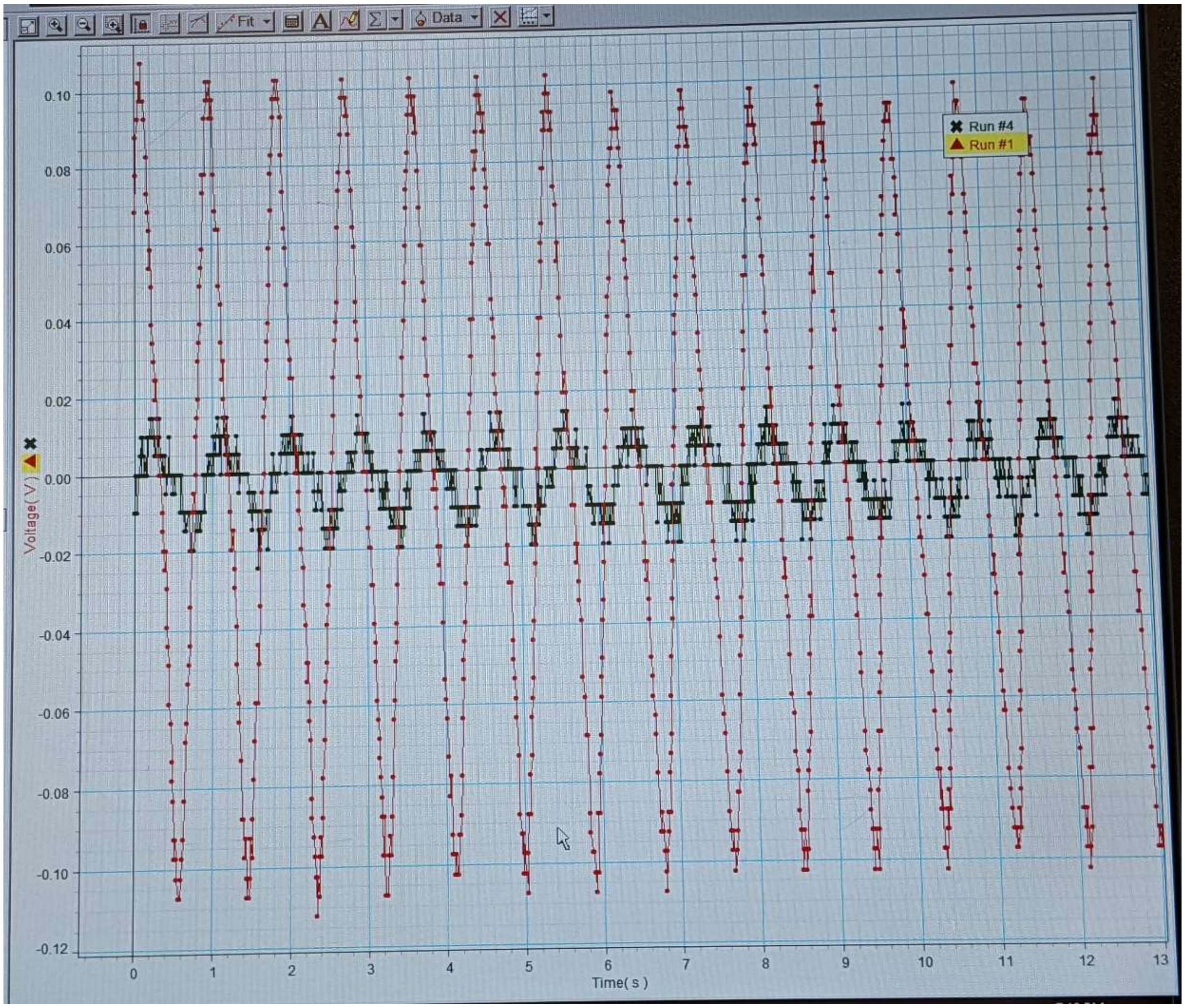
Run #1
Run #2
Run #3
Run #4
Voltage(V)
Time(s)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
0
5
10
15
20
25
30
35
40
45
50
55
60



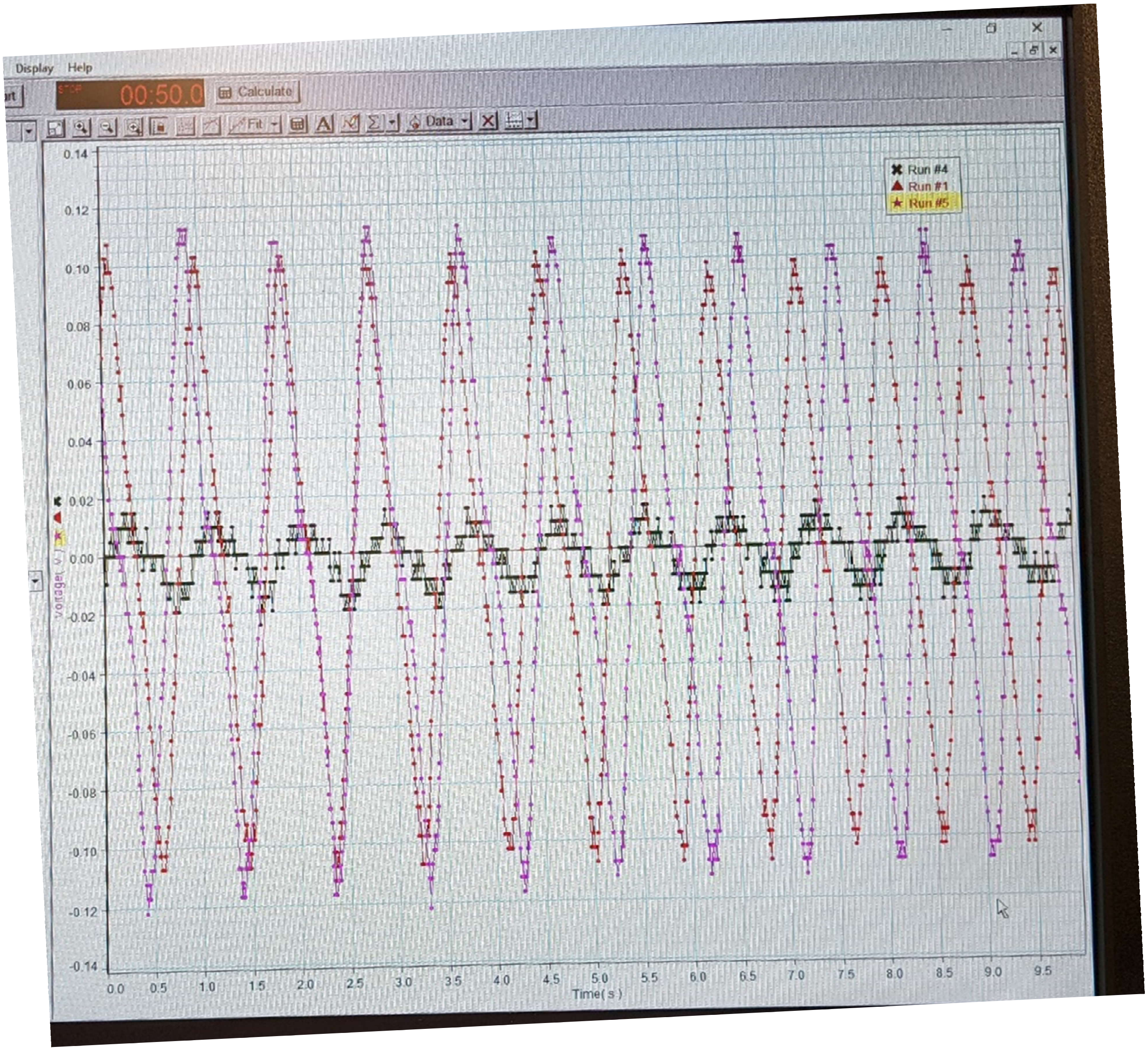
Fit
Data
Run #1
Run #2
Run #3
Run #4
Voltage (V)
Time (s)



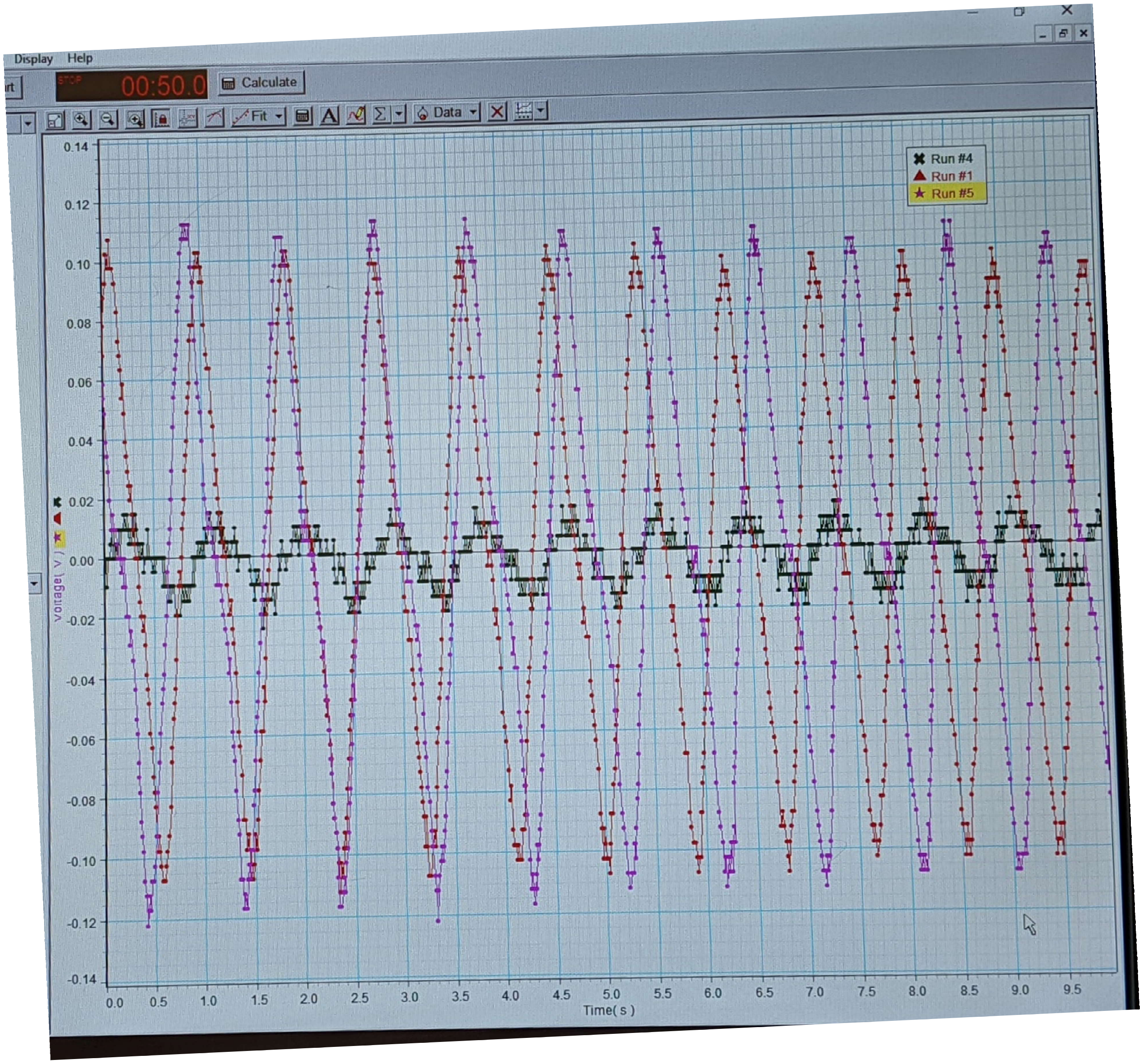
splay Help
00:45.0
Calculate
Fit
Data
Run #4
Run #1
Voltage (V)
Time(s)
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
0
1
2
3
4
5
6
7
8
9
10
11
12
13



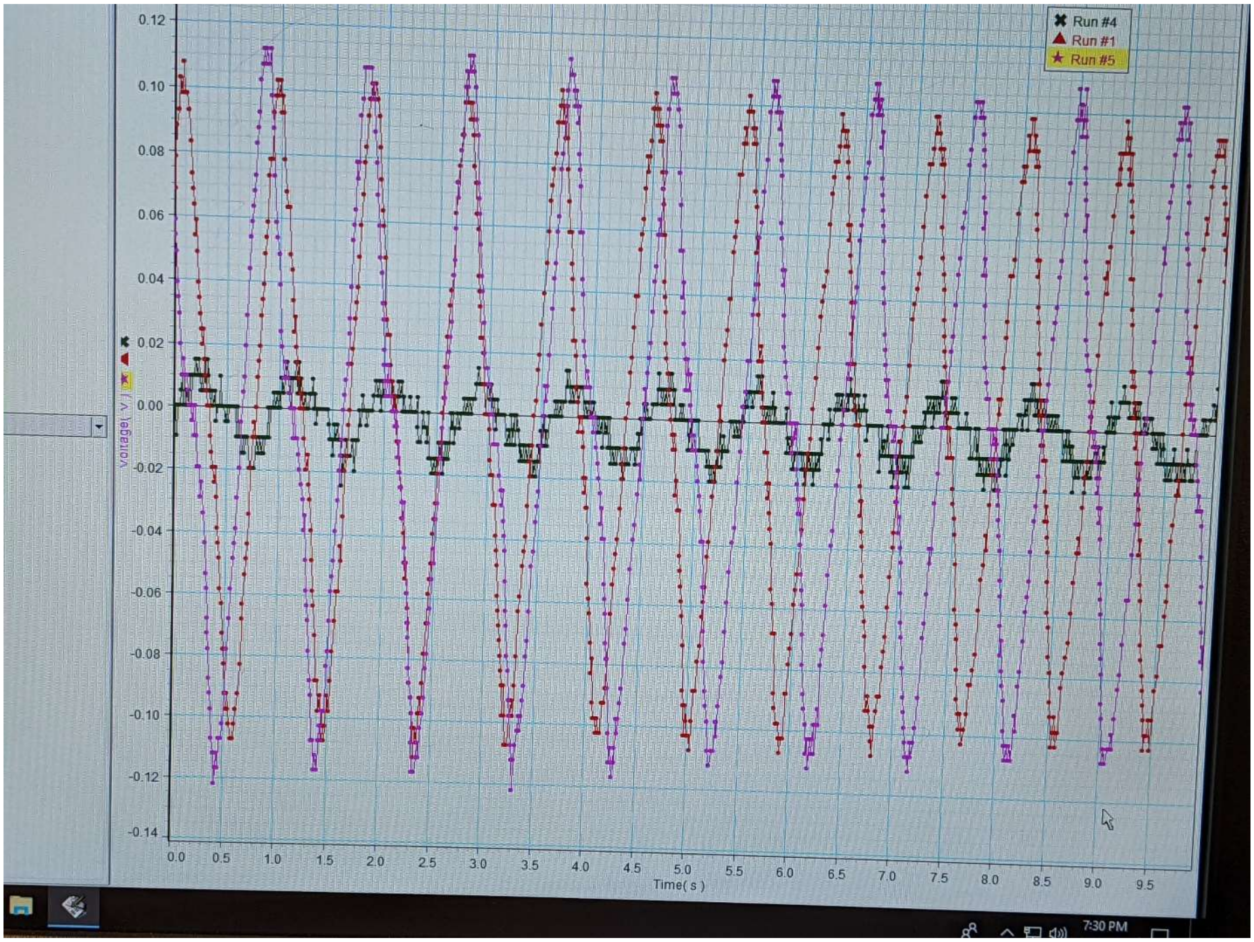
Fit
Data
Run #4
Run #1
Voltage(V)
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Time(s)



Display Help
00:50.0
Calculate
Fit
Data
Run #4
Run #1
Run #5
Voltage(V)
Time(s)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5



Display Help
00:50.0
Calculate
Fit
Data
Run #4
Run #1
Run #5
Voltage(V)
Time(s)


Run #4
Run #1
Run #5
Voltage (V)
Time(s)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
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